

## Introduction to IoT Application Development for Smart City

**Objective:** The primary objective of this course is to equip students to tackle real-world challenges in the Smart City sector, fostering a deep understanding of IoT concepts and their practical application. Participants will be trained hands-on in both electronics and software skills which are required to build, manage, and support IoT-based systems in the context of urban development.

### Pre-requisite:

- Understanding of computer operations, including file management, basic software usage, and navigation.
- Willingness to learn

### Outline of Topics:

Sl No	Name of the Topic	Duration(Hrs)	
		Theory	Lab
1	Introduction to IoT and Fundamental Building Blocks	3	
2	Example Use Case of IoT Application	1	-
3	Fundamentals of Electronics	1	
4	IoT Gateway & Microcontrollers	2	
5	IoT Communication Protocols	1	
6	Software stack for Industrial IoT Application Development	3	
7	IoT Services & Cloud Computing using AWS.	2	
8	Working Principles of Sensors:	2	
9	Smart Parking System		4
10	Smart Train Coach		4
11	Smart Waste Management		4
12	Road Safety and Energy Saving System		3
13	Pollution control- Air Quality Monitoring		3
14	LPG gas for industries		4
15	Grain distribution System		5
16	Structural Bridge Monitoring		4
17	Energy Monitoring and Management		4
18	Project		10

**Duration:** 60 Hrs (Theory: 15 Hrs, Practical: 45 Hrs)

### Detailed Syllabus:

#### 1. Introduction to IoT and Fundamental Building Blocks-

Understand the global impact of IoT on industries and daily life, recognizing its role in addressing challenges and driving innovation.

Explore IoT's influence on sectors like healthcare, agriculture, transportation, and smart cities, while also discussing job opportunities. Key components like input, output, and processing in IoT are explained in this module.

Crucial topics such as Introduction to IoT, Why Learn IoT, Impact on the World, Job Opportunities, and Fundamental Building Blocks are also explained in this module.

## 2. Example Use Case of IoT Application-

Gain hands-on experience building a demo IoT application, providing them with a comprehensive understanding of how an IoT application functions.

## 3. Fundamentals of electronics-

Acquire the skills to test electronic components for functionality and reliability. They will grasp the principles of circuit testing, gaining insights into how electronic circuits operate and troubleshooting common issues.

Understand soldering and desoldering techniques, essential for assembling and repairing electronic devices. Explore topics like Electronic Measuring Instruments, Parallel and Series Circuits, Analog and Digital Circuits, Breadboard Connections, Signal Amplification using OPAMP, and handling SMD Surface Mount Devices.

## 4. IoT Gateway & Microcontrollers-

Learn how to use Raspberry Pi as an IoT gateway. Set up various aspects of Raspberry Pi, including GPIO, audio output, memory, processor, and the use of a Micro SD card. Learn about VNC connections, set up VNC, and use the VNC Viewer for remote access to Raspberry Pi, Components of Arduino Uno- a popular microcontroller in IoT projects.

## 5. IoT Communication Protocols-

Explore Bluetooth for short-range data transfer in IoT.

They will also understand WiFi protocols for high-speed, long-range connectivity, SPI for synchronous communication between microcontrollers and peripherals. Learn UART fundamentals and I2C for multi-device communication in IoT systems.

## 6. Software stack for Industrial IoT Application Development-

Understand the basics of circuit design through an overview of Circuit Designer. Explore the simplicity of coding with Block Programming techniques. Familiarize yourself with Python Direct IDE for streamlined Python development. Gain an introduction to Python, covering fundamental concepts (Data types, arithmetic operators, variables, functions, loops). Python coding through a block-based approach, enhancing comprehension and practical application.

## 7. IoT Services & Cloud Computing using AWS-

AWS for seamless IoT integration, implement mobile browser to IoT gateway communication, understand cloud computing's role in efficient data management, and learn practical steps for AWS account setup and cost-effective project management

## 8. Working Principles of Sensors-

Upon course completion, participants will gain an overview of various sensors like flame sensor, gas sensor, IR sensor, Hall effect sensor, keypad, LDR sensor, metal detection sensor, motion detection / PIR sensor, particulate matter sensor, vibration sensor, raindrop sensor, ultrasonic sensor can be used in different applications along with the fundamental working principle and functionality of these sensors. Explore the role of transducers in converting physical quantities into measurable electrical signals. Learn the importance of sensor calibration for accurate and reliable data acquisition in IoT applications.

## 9. Smart Parking System-

Students develop a smart parking system using various sensors such as echo sensors and LEDs. They learn to detect vehicle presence and program algorithms for efficient parking management

**10. Smart Train Coach -**

In this module, students will be guided to create a solution for differently-abled individuals who face challenges boarding trains due to the gap between the platform and train coach. The curriculum will cover the study of sensors and components, including their working principles, which will be applied in crafting this solution. Specifically, students will gain insights into the working principles of IR sensors and servo motors as part of this learning experience.

**11. Smart Waste Management-**Students work on a solution to address the issue of waste bins not being emptied on time. They learn about waste management, sensor technology, and programming for timely waste disposal, preventing germs and diseases.

**12. Road Safety and Energy Saving System-**Build a road safety solution to avoid accidents on turning, focusing on sensors and energy-saving technologies. An energy-saving application using an LDR (Light Dependent Resistor) to control lights based on ambient light levels. Detects motion, evaluates the need for light using LDR, and turns lights on or off accordingly to save energy.

**13. Pollution control- Air Quality Monitoring-**

Students will learn how particulate matter sensors work. They'll then apply this knowledge to address city pollution by creating an air quality monitoring system, facilitating informed actions for carbon emission reduction.

**14. LPG gas for industries-** In this application, students will understand the working principles of advanced sensors such as gas sensors and flame sensors. They will engage in developing an IoT-based LPG monitoring and safety system, capable of providing real-time data on the weight of an LPG cylinder. This system also covers the safety measures needed while using the cylinder. It will instantly close the valve if any leakage is detected and notify the user about the same.

**15. Grain distribution System-**In this module, students will be tasked with developing a smart grain distribution system. This innovative system is designed to allocate the precise amount of grain designated for each individual. Students will also learn the working of 4\*4 matrix keypad.

**16. Structural Bridge Monitoring-**

Students will learn to monitor bridge health using a vibration sensor, facilitating informed decisions and timely repairs. It includes developing a real-time notification system for immediate updates on the bridge condition.

**17. Energy Monitoring and Management-**Students can use a simple application to monitor real-time energy parameters like power and voltage. The system allows remote control of appliances and uses motion sensors for automation. The user interface is easy to navigate, making it accessible for students. They will be able to learn the working principle of IR sensor.

**18. Project –**Students shall design and develop new IoT-based solutions that address real-world challenges faced in building smart cities.

**Recommended Hardware:**

1. **IoT Kit** comprising of IoT Gateway based on **Raspberry Pi** microprocessor single board computer and required sensors and actuators.
2. **IoT Kit** comprising of IoT Gateway based on **ESP-32** microcontroller board and required sensors and actuators.

**Recommended Software:**

1. **Cloud-based IoT Applied Learning & Development platform** comprising of -
  - a. Learning Management System for content delivery
  - b. Circuit Designer software
  - c. Block Designer software to build no-code block programs
  - d. Python Programming IDE
  - e. Mobile Application Interface to run, monitor and control IoT applications
  - f. Software interface to create and deploy a custom IoT application